

REMARKS

Claims 1-19 all the claims pending in the application, stand rejected on prior art grounds. In addition, the drawings are objected to for failing to designate prior art and the specification is objected to due to an informality. Applicants respectfully traverse these objections/rejections based on the following discussion.

I. The Prior Art Rejections

Claims 1-4, 6-14, and 16-19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over admitted prior art in view of Comita, et al. (U.S. Patent No. 6,774,040), hereinafter referred to as Comita. Claims 5 and 15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over admitted prior art in view of Comita and further in view of Paton, et al. (U.S. Patent No. 6,811,448), hereinafter referred to as Paton. Applicants respectfully traverse these rejections based on the following discussion.

A. The Rejection of Claims 1-4, 6-14, and 16-19 Based on a Combination of the Admitted Prior Art and Comita

Regarding amended independent claims 1, 10, and 19, the Applicants submit that the admitted prior art in combination with Comita do not teach or suggest the following features: (1) that the ex-situ chemical oxide removal process leaves a remaining amount of oxygen that is both less than 5×10^{12} atoms/cm² on the silicon or silicon germanium surface and sufficient to avoid

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surface roughening and (2) that the chlorine containing environment is pre-selected or chosen so as to remove this remaining amount of oxygen from the silicon or silicon germanium surface and to minimize surface roughening without depositing silicon.

More particularly, neither the prior art alone, nor the prior art in combination with Comita teach or suggest "performing an ex-situ chemical oxide removal process on [said silicon or said silicon germanium] surface so as to remove oxygen from [said silicon or said silicon germanium] surface, and leave a remaining amount of oxygen at [said silicon or said silicon germanium] surface, wherein said remaining amount of oxygen comprises less than 5×10^{12} atoms/cm² and is sufficient to avoid surface roughening of [said silicon or said silicon germanium] surface".

Paragraph [0003] of the specification admits that the "surfaces of Si and SiGe wafers normally become covered with a thin native oxide layer when exposed for more than a few minutes in an oxygen-containing environment. In epitaxial processes, the residual oxide (or oxygen contamination) at the surface of the substrate must be minimized to enable the growth of high-quality epitaxial films." Additionally, paragraphs [0017] and [0019] of the specification admit that a typical method of removing oxide contamination is a hydrogen pre-bake or, alternatively, a combination of an HF etch followed by a moderate hydrogen pre-bake.

However, the patentable feature of leaving an amount of oxygen on the surface that is both less than 5×10^{12} atoms/cm² on the silicon or silicon germanium surface and sufficient to avoid surface roughening is not taught or suggested by the admitted prior art. Specifically, the inventors have observed through study that the typical methods, described above, result in surface roughening and that the surface roughening is related to the removal of surface oxygen

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(see paragraphs [0019] and [0020]). In other words, the inventors determined that removing oxygen from the surface using an HF etch results in surface roughening. However, the inventors also determined that if a small amount of oxygen remains on the surface after the HF etch surface roughening is avoided (see paragraph [0020]). Furthermore, studies revealed that the amount could be less than 5×10^{12} atoms/cm² and still be sufficient to avoid surface roughening (see paragraph [0020]). Thus, while the idea of performing a combination HF etch and hydrogen pre-bake process to remove all oxygen from a silicon or silicon germanium surface is admitted, the feature of performing the HF etch and leaving on the surface an amount of oxygen that is both less than 5×10^{12} atoms/cm² and sufficient to avoid surface roughening is not taught or suggested by the admitted prior art. It is noted that these patentable features may be disclosed in the cross-referenced U.S. Patent Application Serial No. 10/751,208; however, the cross-referenced application can not stand as prior art against the subject application because they were concurrently filed by the same inventive entity and are both also subject to an obligation of assignment to the same company.

Additionally, as mentioned above, neither Comita, nor Comita in combination with the admitted prior art teach or suggest the patentable feature that the chlorine containing environment is chosen so as to remove the remaining amount of oxygen from the silicon or silicon germanium surface and minimize surface roughening without depositing silicon. Rather, Comita discloses a method and an apparatus for uniformly smoothing a silicon or silicon alloy surface and uniformly adding silicon to the surface (see col. 1, lines 60-63). The method disclosed in Comita is distinguishable from that of the claimed invention in that Comita discloses a method of 10/751,207

smoothing a surface, whereas the claimed invention discloses a method that avoids roughening of an already smooth surface. Specifically, Comita two gas mixtures simultaneously flow from different channels into a process chamber and onto a spinning wafer. The gas mixtures each comprises different concentrations of a silicon etchant (e.g., HCL) and a silicon source gas (see col. 1, lines 39-53). The gas mixtures are directed towards different locations on the spinning wafer so that as the etchant of each mixture etches the silicon surface and as the silicon source gas of each mixture adds silicon to the surface a uniformly smooth surface is provided (see col. 1, lines 53-63). Thus, the Comita invention smooths a rough surface by a combination of both etching the silicon surface (which necessarily results in the removal of contaminants) and depositing additional silicon.

Contrarily, the claimed invention avoids roughening an already smooth surface first by leaving a small amount of oxygen on the surface during the ex-situ chemical oxide removal process and then by heating the surface in a chlorine containing environment that is pre-selected so as to remove the remaining amount of oxygen from the surface and minimize surface roughening without depositing silicon. Specifically, a chlorine containing gas, such as a HCL alone or a mixture of HCL with any combination of SiH_4 , DCS, SiHCl_3 , Si_2H_6 and GeH_4 can be chosen for the chlorine containing environment (see paragraph [0033]). Additionally, the mixture can be specifically chosen to have a zero deposition rate (so that no silicon will be deposited during the hydrogen pre-bake process) (see paragraph 0026)). Then, the combination of partial pressure of the gas or gases in the mixture, chamber pressure, temperature, and bake time is chosen so that the chlorine passivates the silicon or silicon germanium surface thereby

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allowing the heating process to remove the surface oxygen without roughening the silicon or silicon germanium surface (see paragraphs [0026-0027]).

Therefore, independent claims 1, 10 and 19 are patentable over the admitted prior art in view of Comita. Furthermore, dependent claims 2-9 and 11-18 are similarly patentable, not only by virtue of their dependency from a patentable independent claim, but also by virtue of the additional features of the invention they define. Moreover, the Applicants note that all claims are properly supported in the specification and accompanying drawings, and no new matter is being added. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections.

III. Formal Matters and Conclusion

With respect to the objection to the specifications, the specification has been amended, above, to overcome this objection. With respect to the objection to the drawings, a Replacement Sheet is submitted herewith. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the objections to both the specification and the drawings.

Also, in view of the foregoing, Applicants submit that claims 1-19 all the claims presently pending in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.


Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to 10/751,207

discuss any other changes deemed necessary.

Please charge any deficiencies and credit any overpayments to Attorney's Deposit
Account Number 09-0458

Respectfully submitted,

Dated: 9/9/05


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